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PROPELLANT IMPROVEMENT PROGRAM

Volume I, Part I - Compatibility Of Material With Standard HDA

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Edwards, California

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PROGRAM

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FOREWORD

This report covers the work accomplished by the Bell Aerospace Company (BAC) during the period March 1972 through June 1972 on Task 1 - Standard HDA Compatibility, of the Propellant Improvement Program for the Air Force Rocket Propulsion Laboratory, Liquid Rocket Division, Edwards Air Force Base (EAFB), California. The work was conducted under Contract FO4611-72-C-0026 under the direction of AFRPL Project Engineer, Lt. J. J. Bon.

The Project Manager responsible for program supervision was H. Joseph Loftus. The principal investigator responsible for this task was Henry Ph. Heubusch. Other principal contributors in accomplishing the work were:

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ABSTRACT

Sets of static, corrosion tests were performed to evaluate candidate materials being considered for use with standard HDA (High Density Acid), since the latter was known to be relatively corrosive. The tests were performed at temperatures and times representative of anticipated service conditions for each material. Measurements and observations were made both for changes in the acid and the material. This included chemical analyses and corrosion rates calculated from changes in weight. Based on the results, the materials were ranked in one of four categories, ranging from satisfactory for general use to unsatisfactory. A number of aluminum alloys fell in the former category. Stainless steels appear good for limited use. Results for all materials are tabulated in the text. The general conclusion reached was that a better corrosion inhibitor is needed to extend the choice of materials for the design and test engineer. It was recommended that compounds containing fluorine and phosphorous be evaluated.

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SECTION I

INTRODUCTION

Bell Aerospace Company, under Contract FO4611-72-C-0026 from the Air Force Rocket Propulsion Laboratory, screened candidate rocket engine materials through a set of Standard HDA (High Density Acid) compatibility tests. These tests represented part of Task I of a Propellant Improvement Program, as described in Exhibit "A-1" to the contract. Results of these tests are included herein. Other parts of Task I, which deal with several aspects of modified HDA Storability, form the basis for a separate forthcoming report. Pre-release of this report was requested as an aid to design engineers for an advanced Agena project.

SECTION II

SUMMARY

1.0 TEST DESCRIPTION

Fifty-nine candidate rocket engine materials from Airesearch, Bell Aerospace, Fruehauf, Lockheed and TRW were screened through corrosion tests with Standard High Density Acid. This included 19 tests for a total of 7 days at 120°F; 5 tests for a total of 6 hours at 220°F; and 38 tests for a total of 60 days at 90°F, as required by contract. Also, a number of company-sponsored tests were performed at 90°F and at 120°F. In addition to representing time and temperature effects, the tests provided comparisons between parent metals, welds and couples. In most cases, data were obtained for exposure to liquid and vapor. With few exceptions, S/V (Surface of Metal/Volume of Acid) was 1.0 in.$^{-1}$, a value intermediate between conditions in large tanks and small lines.

2.0 TEST PROCEDURE AND ANALYSES

All tests were performed according to standardized procedures for sample preparation, pre and post acid analyses and pre and post specimen evaluation. In select cases, special analyses were made for sample identification and/or identification of films built up on specimens and/or corrosion products dissolved in acid during test. Principal methods of analyses were by electron microprobe and emission spectroscopy. The objects of these analyses were to provide explanation for current tests and a basis for tests with inhibitors other than HF (hydrofluoric acid), as used in Standard HDA. Also, in select cases, metallographic analyses were performed for further interpretation of test effects on materials.

3.0 TEST RESULTS

Test results are presented in Table I of the Appendix. This table shows materials grouped under principal types, such as aluminum alloys, 300 series stainless steels, etc. Each major group is arranged according to the composition of the alloy. The table is further divided to show specific test results for a given material as functions of temperature and time. The results are in terms of a rating scheme commonly applied for materials under consideration for use with rocket propellants. This scheme is depicted in Table II.

Table II considers separately nonmetals and metals. In both cases, the rating for a given material depends both on the degradation in the propellant and its effect on the propellant. Class I materials are satisfactory for general use in contact with the propellant tested. Other classes are restricted in useage.

Referring to Table I again, note that higher temperatures are generally more detrimental to rating than longer periods of exposure. Under the conditions of interest, aluminum alloys are notable for their compatibility with Standard HDA. A better corrosion inhibitor is clearly required to extend the design engineer's choice to other materials.

SECTION III

TECHNICAL DISCUSSION

1.0 SAMPLE PREPARATION

Regardless of source, sample preparation for testing was guided by two principles. The first was that only those mechanical operations required for sample identification and achievement of $S/V = 1.0 \text{ in.}^{-1}$ were to be performed. The second was that only those cleaning operations considered standard practice in nitric acid engine operations were to be performed. Numbering of samples for identification was waived if a danger existed of affecting the surface, as in the case of plated samples. Within limits dictated by sample size for reliable analyses, acid volume was adjusted to meet S/V before the test specimen was reduced in size.

The form in which each material was received for test, its source, and the subsequent mechanical and cleaning operations performed are given in Table III. For convenience, the materials are collected according to test temperature. All materials, including Bell Aerospace Company-sponsored materials are included therein.

2.0 DESCRIPTION OF CORROSION TEST VESSEL

Bell Aerospace has developed a simple, rugged vessel for conducting corrosion tests over a relatively wide range of S/V and temperatures. See Figure 1. The basic unit consists of a heavy wall aluminum cylinder to which is bolted an aluminum cap with handle. To provide an inert surrounding, a Teflon liner and cap are fitted into the vessel. A Teflon hanger is suspended from the cap. The hanger allows exposure of separate specimens to liquid and vapor when the vessel is partly filled with acid.

3.0 CORROSION TEST PROCEDURE

The same corrosion test procedure was used in all cases. Standard HDA was blended and analyzed in accordance with the standardized procedures contained in Reference 1. Then, a known volume was transferred into a Teflon-lined, aluminum, corrosion test vessel containing tared specimens, arranged for exposure one to the liquid and another to the vapor phase. The loaded vessels were held in an oven at constant temperature for the test duration. The acid and specimens were then removed for re-analysis, inspection and weighing. Particular attention was paid to the appearance of the acid, because of concern over suspended corrosion products. Visual and optical examinations were made of the specimens with metallographic analyses, where warranted. Corrosion rates were calculated from change in weight. Weight of deposits removable from the specimens were also noted. In select cases, a combination of emp (electron microprobe), chemical and spectrographic analyses were used to identify the corrosion products in the acid and the films present on the specimens.

4.0 CORROSION TEST RESULTS

The first contractual set of corrosion tests consisted of exposure of specified materials to Standard HDA for 7 days at 120°F. Test conditions supporting chemical analyses and test observations are contained in Tables IV through VI.

4.1 Acids For Corrosion Tests At 120°F

Table IV lists the test conditions. These include the test identification number, the material tested, its source, the type NTO (nitrogen tetroxide) and relative levels of H_2O and HF (hydrofluoric acid) blended by weight with the nitric acid and nitrogen tetroxide, the test duration and temperature and source of ingredients used to prepare the HDA. WFNA-H (white fuming nitric acid-H; H is a code which indicates eighth batch number) was the eighth bottle of nitric acid used at Bell Aerospace Company for these tests. LM-F represents a grade of NTO containing approximately 1.0 wt% (weight-percent) NO, which imparts a green color and has been filtered to remove particulates. The NTO designation Gn Gn signifies that the final product contained all green NTO. As indicated, HF was added to the acid blends from a cylinder of commercially available material. No water was added to the blends.

4.2 Acid Analyses For Corrosion Tests At 120°F

Table V contains the results of pre and post analyses of the acids used for test. Chemical composition is expressed in terms of wt% of the principal ingredients: nitric acid (HNO_3), nitrogen tetroxide in equilibrium with nitrogen dioxide (NO_2), water, and hydrofluoric acid (HF). Corrosion products are expressed in terms of wt% of iron oxide (Fe_2O_3), metal oxides (M_2O_3) and total nitrate (TN). Little buildup in Fe_2O_3 is expected in tests of aluminum. For such tests, it is customary to analyze only for M_2O_3 and to use the aluminum factor to express results as anhydrous, total nitrate. The appearance of the acid is an indication of quality from a use standpoint. Clear acid presents no problem. Particles are suspended corrosion products, generally in a saturated solution.

Experience has demonstrated a level at which particles will not jeopardize operations by plugging orifices, filters, etc. The top level allowed is designated OK. Higher levels are designated P and > P respectively.

The standardized methods of analyses used consisted of a redox titration for NTO, direct determination of water by NIR absorbance, and specific ion electrode analyses of a neutralized sample of acid for fluoride. Iron was determined colorimetrically, since suggested atomic absorption procedures gave low results. Total oxides were determined after ignition. Total nitrates and nitric acid values were by calculation.

4.3 Test Conditions and Acid Analyses - Summary At 120°F

Table VI contains a summary of test conditions and acid analyses. Of most importance is the qualitative and quantitative information about the material tested. The qualitative data are given in terms of the physical appearance of the samples after exposure to acid and its vapors. N.E. designates no effect discernible. Colors for deposits are abbreviated and a general description of the deposits and/or substrate is given.

Quantative data are given in forms of weights of deposits removeable from the test specimens and corrosion rates calculated from changes in weight. Rank is based on one portion of Table II.

4.4 Test Data Computer Code

The numbers in parenthesis in Table VI are codes used to computerize test results for statistical treatment. The definition of this code is shown in Table VII.

4.5 BAC-Sponsored Fruehauf Material Test Results Data

Data for 7 day, 120°F tests of materials under consideration by Fruehauf for construction of a tank truck for HDA service are presented in Tables VIII, IX and X. The computer code of Table VII is applicable to Table X.

4.6 Short Term - High Temperature and Extended Storage - Low Temperature Test Results

Results of short term, high temperature, tests can be seen in Tables XI, XII and XIII. Extended storage tests at 90°F are shown in Tables XIV, XV, XVI. The computer code of Table VII is applicable to Tables XIII and XVI.

4.7 Nonroutine Analyses

Nonroutine analyses are summarized in Table XVII. This table shows that particles lent to HDA by exposure to nonmetals were filtered off, weighed and, as required, identified by spectroscopic analyses, as requested by Airesearch. The films on a cross-section of the metals exposed to HDA were isolated and analyzed by emp, to determine what alloying elements were being attached and what type of protective film, fluoride, oxide, etc. was being formed. Emission spectroscopy and spot tests were used to expand these data. Supplemental spectroscopic data were obtained for residues left after evaporation of solids from corrosion tests. Other analyses, such as gravimetric determination of nickel in the NVR from a test Au/Ni Braze Alloy and carbon analyses and spectroscopy for sample identification, were also performed.

In addition, there were a number of samples where microscopic observation indicated peculiar attack. These were submitted for metallographic analyses. Results are summarized in Table XVII and given in detail in References 2 and 3.

SECTION IV

TECHNICAL DISCUSSION

Close inspection of the tabulated data reveals only a few instances where S/V could not be adjusted to 1.0 in.$^{-1}$. A value of 0.1 in.$^{-1}$ had to be used for a small disc of platinum - cobalt alloy. The total surface of couples was such as to make S/V = 1.0 in.$^{-1}$. Therefore each component was at a smaller value. The proportions can be determined, if desired, from the data in Table III. These data were representative of proportions normally used. Since the couples were easily disassembled, it was possible to calculate the separate corrosion rates for each component. Thus, the double entries in the tables. Although S/V = 1.0 in.$^{-1}$ is reported for all welded samples, those involving bellows segments and parallel sheets welded together represent special cases that are susceptible to crevice corrosion.

It has already been mentioned (in a general way) that where comparisons were possible it appeared higher temperature was more detrimental to a specimen's resistance to HDA than a longer period of exposure at a lower temperature. This, of course, is as it should be, but is reassuring since it indicates that test times, which were reduced with increasing test temperature, were long enough to provide reliable data. On the other hand, one would be penalizing a material to test it at a temperature higher than service conditions. For tests at 90°F, it appears advisable to keep exposure time to at least 30 days. This conclusion is extrapolated from the present tests plus those reported in Reference 4. Review of the latter data applicable to 347 stainless steel is of interest.

A rating of Class II was assigned to 347 stainless steel largely because of an objectionable amount of particulate in the acid after 30 days at 90°F. These tests were conducted with the corrosion test vessels being held in a water bath with their tops in air. This condition permitted some reflux action. When the material was retested for 60 days, the test vessels were stored at uniform temperature in an oven. This change was sufficient to move the material from the Class II into Class I range, thus reinforcing the previous remarks about the importance of matching test and service conditions as closely as possible.

One test involving a couple of 304L stainless steel and Haynes - 25 alloy was rerun because of concern over the relatively high corrosion rate of the Haynes - 25. The repeat test was made with Haynes - 25 which had no past history of acid service. Corrosion rate fell to a reasonable level drawing attention to another important facet of corrosion.

One substitution of material for test was made. A 347 stainless steel/ chrome plated Worthite couple was tested rather than a 302/Worthite couple when it was discovered that only the former was on the acid side of a valve assembly.

A sample received as 304 stainless steel showed unexpected resistance to HDA. Permission was received from the source to verify composition by analysis. A carbon determination coupled with a spectrographic analyses proved the material to be 304L.

A question of identity for another sample was solved by analyses which showed the material to be AM350.

Other nonroutine analyses brought out an interesting point. The identity of the films formed upon exposure to HDA was considered a choice between oxides and/or fluorides. Analyses of eight different type samples by emp showed only fluorides to be present. This finding will be compared with results for similar analyses being performed in support of tests with alternate inhibitors for HDA.

A final comment relates to earlier tests with Standard HDA (References 1 and 4). It appeared useful to combine results from these tests with data obtained under comparable conditions during the present study. Accordingly, Tables XVIII and XIX, covering nonmetallic and metallics respectively, were derived. One thus has immediate reference to the bulk of Standard HDA corrosion test data available to date.

SECTION V

CONCLUSIONS

Fifty-nine candidate materials for rocket engines were screened for HDA service. Those found generally satisfactory are grouped in Table XX. Those found acceptable for repeated, short term exposure are grouped in Table XXI. The ratings for all the materials tested are in the text.

Examination of Table XX shows several aluminum alloys with a Class I rating. Most of the data are from tests of seven days duration at 120°F. The one alloy in this group also tested at 90°F bore out the expectation that the rating would not fall at a lower temperature. Only three stainless steel samples exhibited a Class I rating, and this at 90°F. A poorer rating was obtained in both cases where one of the original group was tested at higher temperature. The actual values are shown in the table, set off by parentheses. A similar pattern is observed for other metals and nonmetals.

Examination of Table XXI shows several of the 300 stainless steels and the balance of the aluminum alloys. The values in parentheses are actual values. In addition, several other metals and nonmetals are available to design engineers. Rulon LD was not included in the Table because anomalous results were obtained as a function of temperature. Further testing would be required to obtain technical endorsement for this material.

The general conclusion from all the tests was that an improved corrosion inhibitor is needed to extend the range of materials for use in HDA. The search for such an inhibitor is in progress.

SECTION VI

REFERENCES

1. "Propellant Characterization Program", H. Ph. Heubusch, Bell Aerospace Co., Report No. 8096-910082, September 1, 1970

2. "Metallurgical Analysis Of AM-350 Precipitation Hardening Stainless Steel... Corrosion Samples Exposed To A High Density Acid Environment", J. Salvaggi, Bell Aerospace Co. Memo dated 8 June 1972.

3. "Metallurgical Examination Of Samples Exposed To HDA For 60 Days At 90°F, H. G. Kammerer, Bell Aerospace Co. Memo dated 23 June 1972.

4. "Technical Proposal For Propellant Improvement Program", Bell Aerospace Co. Report No. D8643-953002, 7 January 1972

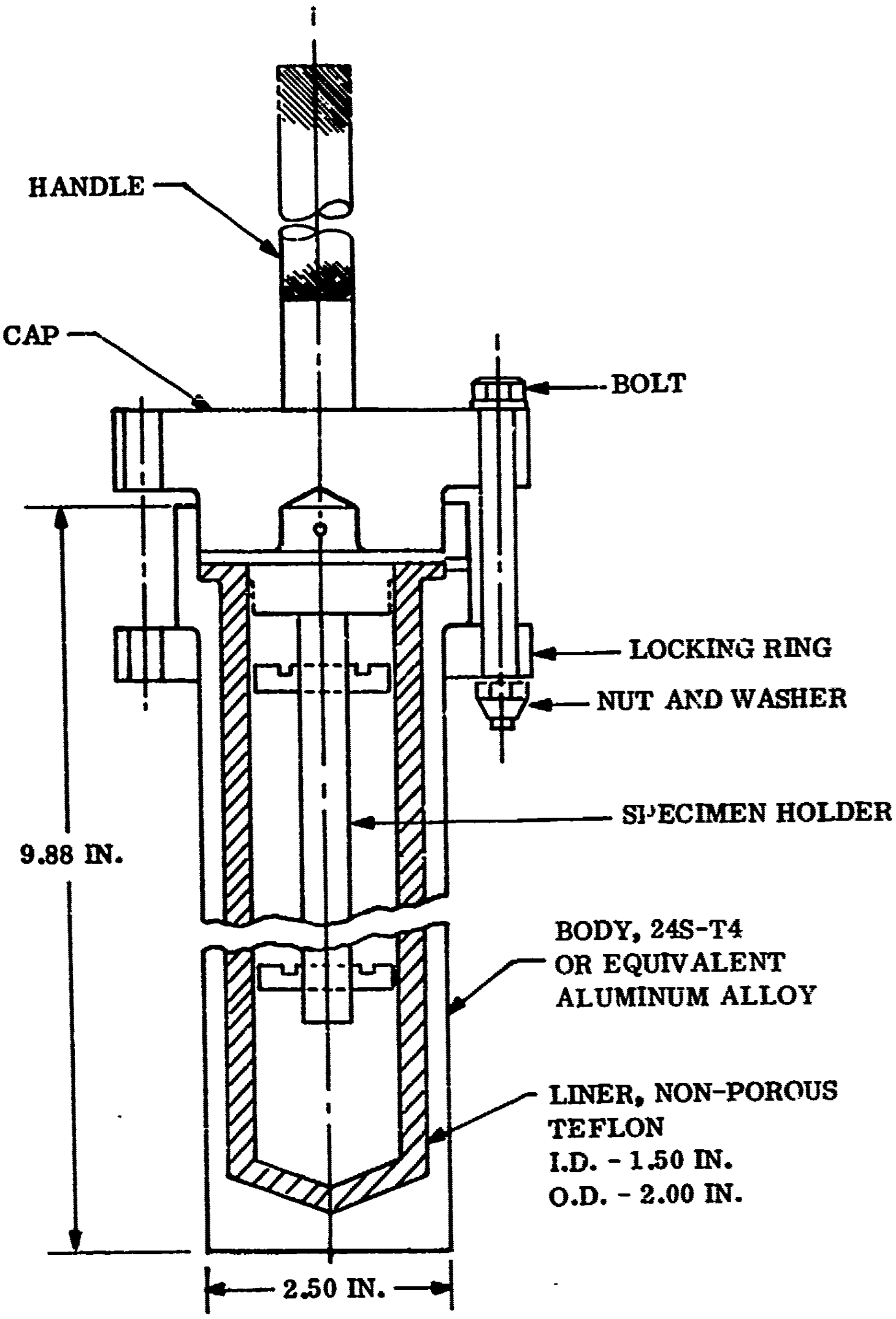

Figure 1. HDA Corrosion Test Vessel

TABLE I

RATINGS OF MATERIALS FOR SERVICE IN STANDARD HDA (1 of 3)

Material	Ratings (1)		
	6 Hours At 220°F	7 Days At 120°F	60 Days At 90°F
Aluminum Alloys			
356A Cast	---	---	I
356-T6	II	---	I
A356-T6 Hard Anodized	IV	---	---
356-T6/304 Couple	---	II/II	---
356-T6/304L Couple	---	II/II	---
2021/2021 Weld	---	---	II
2219/2219 Weld	---	---	II
5086	---	I (2)	---
5086 Welded	---	I (2)	---
5454-0	---	I (2)	---
5454-H32	---	I (2)	---
5454-H32 Welded	---	I (2)	---
6061-T6	---	I (2)	I
6061-T6 Welded	---	I (2)	---
6061-T6/304L Couple	II/1	II/1	---
Nituff On 6061 Al	---	II	---
300 Series Stainless Steels			
302/304L Weld	---	II	---
304/304-308 Filler Weld	---	---	II
304L/304L TIG Weld	---	---	II
304L	II	---	I/I
304L Work Hardened	---	---	II
304L/Haynes-25 Couple	---	II/II-III	---
316	---	II	---

(1) Refer to Table II For Rating Scheme

(2) Bell Aerospace-Sponsored Test

TABLE I (2 of 3)

Material	Ratings 1		
	6 Hours At 220°F	7 Days At 120°F	60 Days At 90°F
300 Series Stainless Steels (cont)			
316 Spring Wire	---	---	I
321	---	---	II
321/321 - Bellows Res. Weld	---	---	II
321/321-347 Filler Weld	---	---	II
347	---	III 2	I
347/347 TIG Weld	---	III 2	II
347/AM350 TIG Weld	---	III	---
347/Chrome Plated Worthite Couple	---	II/I	---
Other Metals			
M-50 Alloy	---	---	II
440C	---	III	II
440C - Chrome Plated	---	IV	---
440C - Rhodium Plated	---	---	III
440C - Chromized	---	---	IV
AM350 Bellows	III	---	---
AM350 Screen	---	---	II
17-4 PH H1025	---	---	I
17-7 PH RH 950	---	II	---
17-7 PH RH 1050	---	II	II
17-7 PH Fully Annealed - Cond, A	---	---	I
17-7 PH Spring Wire	---	---	I
17-7 PH Torque Tube	---	II 2	I 2
ARMCO 21-6-9	---	III	II
20-Cb-3 (Carpenter 20 Cb)	---	II 2	II

1 Refer to Table II For Rating Scheme

2 Bell Aerospace-Sponsored Test

TABLE I (3 of 3)

Material	Ratings ⚠1		
	6 Hours At 220°F	7 Days At 120°F	60 Days At 90°F
Other Metals (cont)			
Haynes - 25 Screen	---	II	---
Haynes - 25 Rhodium Plated	---	---	III
Haynes - 25 Chromized	---	---	III
Latrobe MP-35-N	---	III ⚠2	II
Pt - Co Alloy	---	I	---
Au/Ni Braze Alloy	---	---	III
Columbium C-130 (W̄R512E Coat)	---	---	III
Nonmetals			
KEL-F 81	---	II	II
KEL-F 5500	---	---	III
Rulon A	---	---	II
Rulon LD	---	II	III
Rulon 123	---	II	I
25% Glass Filled Teflon	---	---	II

⚠1 Refer to Table II For Rating Scheme

⚠2 Bell Aerospace-Sponsored Test

TABLE II

COMPATIBILITY CLASSIFICATION OF MATERIAL
WITH ROCKET PROPELLANTS

Compatibility Classification of Nonmetals				
Class	I	II	III	IV
Volume Change in Percent	0 To +25	-10 To +25	-10 To +25	< -10 Or $> +25$
Durometer Reading	±3	±10	±10	< -10 Or $> +10$
Effect On Propellant	None	Slight Change	Moderate Change	Severe
Visual Examination	No Change	Slight Change	Moderate Change	Severely Blistered, Cracked, Or Dissolved
General Usage	Satisfactory For General Use	Satisfactory For Repeated Short-Term Use	Satisfactory For Short-Term Use	Unsatisfactory
Compatibility Classification of Metals				
Class	I	II	III	IV
Rating	Excellent	Good	Fair	Poor
Corrosion Rate In Mils/Year	< 1	< 5	5 To 50	> 50
Decomposition Of Propellant	No	No	Some	Extensive
Shock Sensitivity	No	No	No	Yes

NOTE: The classification of a material is based on the lowest rating of any of the properties

TABLE III

SAMPLE PREPARATION (1 of 4)

Test No.	Material	Source	Test Temp °F	Form in Which Sample Was Received	Mechanical Operation(s)	Cleaning
190	316 SS	Airesearch	120	Sheet Stock, 3/64-in. thick	Sheared, drilled, deburred, numbered	Procedure A △1
192	440C	Airesearch	120	Bar Stock, 1 1/4-in. diameter	Cut in two with emery wheel, numbered	Procedure A
200	17-7 PH RH950	Airesearch	120	Sheet Stock, 1/32-in. thick	Sheared, drilled, deburred, numbered	Procedure A
201	17-7 PH RH1050	Airesearch	120	Sheet Stock, 1/32-in. thick	Sheared, drilled, deburred, numbered	Procedure A
229	17-7 PH Torque Tube	Bell Aerospace	120	Machined Part, 1/8-in. capillary	None	Procedure A
197	Kel-F 81	Airesearch	120	Rod, 1-in. diameter	Machined 1/8-in. wafers on lathe, numbered	Procedure C
195	Rulon LD	Airesearch	120	Rod, 1-in. diameter	Machined 1/8-in. wafers on lathe, numbered	Procedure C
196	Rulon 123	Airesearch	120	Rod, 1-in. diameter	Machined 1/8-in. wafers on lathe, numbered	Procedure C △1
188	Cr plated 440C	Airesearch	120	Plated (0.4 mil) Ring (except ID), 3/4-in. OD, 3/8-in. ID, 1/4-in. thick	None	Acetone degrease, oven dry at 190°F for 30 min.
189	Pt-Co Alloy	Airesearch	120	Disc, Rough Faces, 3/8-in. diameter	None	Acetone degrease, oven dry at 190°F for 30 min.
191	NITUFF on 6061 Al	Airesearch	120	Plate, 1/4-in. thick, NITUFF on all but 2 ends	None	Acetone degrease, oven dry at 190°F for 30 min.
186	Armco 21-6-9	Airesearch	120	Disc, 1/4-in. thick	Sawed, drilled, deburred, numbered	Procedure A △1
198	Haynes-25 Screen	Bell Aerospace	120	Cone in cylinder, 1/2-in. diameter, 1/2-in. long, 6 mil wire	None	Procedure A △1
185	347/AM 350 Tig Weld	Airesearch	120	Section of bellows	Deburred, numbered	Acetone degrease, oven dry at 190°F for 30 min.
228	302/304L Weld	Bell Aerospace	120	Part of 304L Impeller/302 Pin, 1/8-in. diameter	Sawed, deburred, numbered	Procedure A △1
230	356-T6/304 Couple	Bell Aerospace	120	Machined Plate, 5/64-in. thick/Part of Bearing Race, 1/16-in. thick	Drilled, deburred, numbered/Sawed drilled, deburred, numbered/Coupled with Teflon nut and bolt	Procedure B/Procedure A △1 △3
231	356-T6/304L Couple	Bell Aerospace	120	Casting, 1/4-in. thick/bar stock, 1-in. diameter	Sawed, drilled, deburred, numbered/ Machined on lathe, drilled, deburred, numbered/Teflon nut and bolt	Procedure B/Procedure A △1 △3
232	6061-T6/304L Couple	Bell Aerospace	120	Sheet Stock, 1/16-in. thick/Bar Stock, 1-in. diameter	Sheared, drilled, deburred, numbered, anodized △2 /Machined on lathe, drilled, deburred, numbered/Teflon nut and bolt	Oven dried at 190°F for 30 min./Procedure A △1 △3
226	304L/Haynes-25 Couple	Bell Aerospace	120	Bar Stock, 1-in. diameter/Cylinder as above	Machined on lathe, drilled, deburred, numbered/None/Teflon nut and bolt	Procedure A/Procedure A, △1 △3
227	347/Cr plated Worthite Couple	Bell Aerospace	120	Sheet Stock, 1/16-in. thick/Bar Stock 1-in. diameter	Sheared, drilled, deburred, numbered, /Machined on lathe, drilled, deburred, numbered, plated (1 mil)/Teflon nut and bolt	Procedure A/Acetone degrease, oven dried at 190°F for 30 min. △1 △3
221	356-T6	Bell Aerospace	220	Milled Plate, 1/32-in. thick	Machined on lathe, drilled, deburred, numbered	Procedure B △1

△1 See Sheet 4

△2 Sulfuric acid anodize with sodium dichromate seal

△3 Cleaned at component level

TABLE III (2 of 4)

Test No.	Material	Source	Test Temp °F	Form In Which Sample Was Received	Mechanical Operation(s)	Cleaning
222	A356-T6 Hard Anodized	Bell Aerospace	220	Plate, 1/2-in. thick, Anodized (11 mil) 1 side	Sawed, drilled, deburred, numbered	Acetone degrease, oven dried at 190°F for 30 min.
223	304L	Bell Aerospace	220	Bar Stock, 1-in. diameter	Machined on lathe, drilled, deburred, numbered	Procedure A [1]
224	AM350	Bell Aerospace	220	Section of bellows	Sawed, deburred, drilled, numbered	Acetone degrease, oven dried at 190°F for 30 min.
225	6061-T6/304L Couple	Bell Aerospace	220	Sheet stock, 1/16-in. thick/Bar Stock, 1-in. diameter	Sheared, drilled, deburred, numbered, anodized [2]/Machined on lathe, drilled, deburred, numbered/Teflon nut and bolt	Acetone degrease, oven dried at 190°F for 30 min.
216	356A Cast	LMSC	90	Machined and Ground Plate, 1/8-in. thick	Drilled, deburred, numbered	Procedure B [1]
203	6061-T6	Bell Aerospace	90	Sheet Stock, 1/16-in. thick	Sheared, drilled, deburred, numbered	Procedure B
217	356-T6	Bell Aerospace	90	Casting, 1/4-in. thick	Sawed, drilled, deburred, numbered	Procedure B
211	304(L)	LMSC	90	Milled Plate, 1/4-in. thick	Sawed, drilled, deburred, numbered	Procedure A
238	304L	Bell Aerospace	90	Bar Stock, 1-in. diameter	Machined on lathe, drilled, deburred, numbered	Procedure A
219	304L Work Hardened	TRW	90	Shim Stock, 4 mil thick	Sheared, numbered	Procedure A
247	316 Spring Wire	Airesearch	90	Wire, 3/64-in. diameter	Sheared	Procedure A
218	321	LMSC	90	Sawed Plate, 3/8-in. thick	Sawed, drilled, deburred, numbered	Procedure A
204	347	Bell Aerospace	90	Sheet Stock, 1/16-in. thick	Sheared, drilled, deburred, numbered	Procedure A
210	AM350 Screen	LMSC	90	Screen, 10 mil	Sheared	Procedure A
248	17-4 PH H 1025	LMSC	90	Sawed Plate, 5/32-in. thick	Drilled, deburred, numbered	Procedure A
208	17-7 PH PH 1050	LMSC	90	Machined part, 1/4-in. thick	Sawed, deburred, numbered	Procedure A
206	17-7 PH Full Annealed (Condition A)	TRW	90	Sheet Stock, 1/64-in. thick	Sheared, deburred, numbered	Procedure A
239	440C	Airesearch	90	Bar Stock, 1 1/4-in. diameter	Machined on lathe, drilled, deburred, numbered	Procedure A
240	Armco 21-6-9	Airesearch	90	Disc, 1/4-in. diameter	Sawed, drilled, deburred, numbered	Procedure A
241	20-Cb-3 (Carpenter 20 Cb)	Airesearch	90	Bar Stock, 3/8-in. diameter	Sawed, drilled, deburred, numbered	Procedure A
249	17-7 PH Spring Wire (CH 900)	Airesearch	90	Wire, 1/64-in. diameter	Sheared	Procedure A
237	17-7 PH Torque Tube	Bell Aerospace	90	Machined Part, 1/8-in. capillary	None	Procedure A
233	Kel-F 5500	Bell Aerospace	90	O-Ring, 3-in. diameter, 1/8-in. thick	None	Procedure C
234	Kel-F 81	Airesearch	90	Rod, 1-in. diameter	Machined 1/8-in. thick wafers on lathe, drilled, deburred	Procedure C [1]

[1] See Sheet 4

[2] Sulfuric acid anodize with sodium dichromate seal

TABLE III (3 of 4)

Test No.	Material	Source	Test Temp °F	Form In Which Sample Was Received	Mechanical Operation(s)	Cleaning
209	Rulon A	Airesearch	90	Rod, 3/8-in. diameter	Machined 1/8-in. thick wafers on lathe, deburred	Procedure C [1]
235	Rulon LD	Airesearch	90	Rod, 1-in. diameter	Machined 1/8-in. thick wafers on lathe, drilled, deburred	Procedure C
236	Rulon 123	Airesearch	90	Rod, 1-in. diameter	Machined 1/8-in. thick wafers on lathes, drilled, deburred	Procedure C [1]
242	Chromized Haynes-25	Airesearch	90	Machined Part	Sawed, drilled, deburred, ends protected with Teflon caps	Acetone degrease, oven dry at 190°F for 30 min.
250	Rh plated Haynes-25	Airesearch	90	Disc, 1-in. diameter	None	Acetone degrease, oven dry at 190°F for 30 min.
243	Chromized 440C	Airesearch	90	Bar, 1/4-in. diameter	Sawed, drilled, deburred, ends protected with Teflon caps	Acetone degrease, oven dry at 190°F for 30 min.
251	Rh plated 440C	Airesearch	90	Disc, 1-in. diameter	None	Acetone degrease, oven dry at 190°F for 30 min.
246	M-50 Alloy	Airesearch	90	Machined Race, 1/8-in. thick	Sawed, deburred, numbered	Acetone degrease, oven dry at 190°F for 30 min.
252	Latrobe MP-35-N	Airesearch	90	Bar Stock, 1-in. diameter	Machined, drilled, deburred, numbered	Procedure A [1]
207	Au/Ni Braze Alloy	LMSC	90	Slip Ring, 9/16-in. ID	None	Acetone degrease, oven dry at 190°F for 30 min.
240	25% Glass Filled Teflon	LMSC	90	Sheet, 1/8-in. thick	Sheared, drilled, numbered	Procedure C [1]
205	Columbium C-103 (W R R512E Coat)	TRW	90	Sheet Stock, 1 1/2-in. long, 5/64-in. thick; Coat on both faces	None	Acetone degrease, oven dry at 190°F for 30 min.
215	304/304-308 Filler Weld	LMSC	90	Sawed Plate, 5/16-in. thick	Sawed, drilled, deburred, numbered	Procedure A [1]
253	304L/304L Tig Weld	Airesearch	90	Sheet Stock [4], 5/64-in. thick	Sawed, drilled, deburred, numbered	Procedure A [1]
214	321/321-347 Filler Weld	LMSC	90	Sawed Plate, 5/16-in. thick	Sawed, drilled, deburred, numbered	Procedure A [1]
212	321/321 Welded Bellows	LMSC	90	Section of bellows	Sawed, drilled, deburred, numbered	Acetone degrease, oven dry at 190°F for 30 min.
234	347/347 Tig Weld	Airesearch	90	Sheet Stock [4], 3/64-in. thick	Sawed, drilled, deburred, numbered	Procedure A [1]
244	2021/2021 Weld	LMSC	90	Sawed Plate, 5/16-in. thick	Drilled, deburred, numbered	Procedure B [1]
245	2219/2219 Weld	LMSC	90	Sheet Stock, 5/16-in. thick	Sawed, drilled, deburred, numbered	Procedure B [1]

[1] See Sheet 4

[4] Parallel Sheets welded together

TABLE III (4 of 4)

Test No.	Material	Source	Test Temp °F	Form In Which Sample Was Received	Mechanical Operation(s)	Cleaning
	SPECIMEN CLEANING PROCEDURE A - STAINLESS STEEL SPECIMENS					
	1. Acetone degrease					
	2. Detergent wash (1 Vol% Liquinox at 70°F) with abrasion (Scotchbrite) if scale noted					
	3. Tap Water rinse					
	4. Passivation in 30-40 vol % nitric acid at 140°F for 30 minutes					
	5. Distilled water rinse					
	6. Oven dry at 190°F for 30 minutes					
	SPECIMEN CLEANING PROCEDURE B - ALUMINUM SPECIMENS					
	1. Acetone degrease					
	2. Descale in 22-28 wt% sulfuric acid with 3-4 wt% dichromate at 140-160°F for 10-15 minutes					
	3. Tap water rinse					
	4. Desmut in 23 Vol % nitric acid with 1.7 Vol % HF at 70°F for 1 minute					
	5. Distilled water rinse					
	6. Oven dry at 190°F for 30 minutes					
	SPECIMEN CLEANING PROCEDURE C - NONMETALLIC SPECIMENS					
	1. Detergent wash (1 Vol % Liquinox at 70°F)					
	2. Distilled water rinse					
	3. Blot					
	4. Oven dry at 190°F for 30 minutes					

TABLE IV

ACIDS FOR CORROSION TESTS AT 120°F (1 of 2)

Test No.	Material	Source	NTO	H_2O (1)	HF (2)	Time (days)	Temp. (°F)	Acid Type	NTO	HF Type	H_2O Added
185	347/AM350 TIG Weld	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
186	ARMCO 21-6-9	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
188	Cr plated 440C	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
189	Pt-Co. Alloy	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
190	316 ELC	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
191	NITUFF on 6061 Al	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
192	440C	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
195	Rulon LD	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
196	Rulon 123	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
197	Kel-F 81	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
198	Haynes-25 Screen	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
200	17-7 PH RH 950	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
201	17-7 PH RH 1050	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
226	304L/Haynes-25 Couple	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
226'	304L/Haynes-25 Couple	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-I	LM-F	Cyl.	No
227	347/Cr plated Worthite Couple	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No

(1) Lo = <0.5 Weight-Percent

(2) Med = 0.4 to 0.8 Weight-Percent

TABLE IV (2 of 2)

Test No.	Material	Source	NTO	H_2O (1)	HF (2)	Time (days)	Temp. (°F)	Acid Type	NTO	HF Type	H_2O Added
228	302/304L Weld	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
229	17-7 PH Torque Tube	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-I	LM-F	Cyl.	No
230	356-T6/304 Couple	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-I	LM-F	Cyl.	No
231	356-T6/304L Couple	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-I	LM-F	Cyl.	No
232	6061-T6/304L Couple	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-I	LM-F	Cyl.	No

(1) Lo = <0.5 Weight-Percent

(2) Med = 0.4 to 0.8 Weight-Percent

TABLE V

ACID ANALYSES FOR CORROSION TESTS AT 120°F (1 of 2)

Test No.	Time	HNO_3 (wt %)	NTO (wt %)	H_2O (wt %)	HF (wt %)	Fe_2O_3 (wt %)	M_2O_3 (wt %)	TN (wt %)	Physical Appearance
185	Pre	53.5	45.5	0.2	0.7	0.0001	0.0012	0.005	Clear
	Post					0.0051			Many Particles
186	Pre	53.5	45.5	0.2	0.7	0.0001	0.0012	0.005	Clear
	Post					0.0074			Many Particles
188	Pre	53.5	45.5	0.2	0.7	0.0001	0.0012	0.005	Clear
	Post					0.0047			Clear
189	Pre	53.5	45.5	0.2	0.7	0.0001	0.0012	0.005	Clear
	Post						0.0036		Clear
190	Pre	53.5	45.5	0.2	0.7	0.0001	0.0012	0.005	Clear
	Post					0.0051			Clear
191	Pre	53.5	45.5	0.2	0.7	0.0001	0.0012	0.005	Clear
	Post								OK △1
192	Pre	54.1	44.9	0.3	0.8	0.0004	0.0012	0.005	Clear
	Post					0.0027			Clear
195	Pre	54.1	44.9	0.3	0.8	0.0004	0.0012	0.005	Clear
	Post								OK
196	Pre	54.1	44.9	0.3	0.8	0.0004	0.0012	0.005	Clear
	Post								OK
197	Pre	54.1	44.9	0.3	0.8	0.0004	0.0012	0.005	Clear
	Post								OK
198	Pre	54.5	44.6	0.2	0.7	0.0001	0.0005	0.002	Clear
	Post					0.0003			Clear
200	Pre	54.1	44.9	0.3	0.8	0.0004	0.0012	0.005	Clear
	Post					0.0074			Clear
201	Pre	54.1	44.9	0.3	0.8	0.0004	0.0012	0.005	Clear
	Post					0.0066			Clear
226	Pre	54.4	44.7	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post					0.0009			Clear
226'	Pre	55.1	44.0	0.2	0.7	0.0001	0.0004	0.010	Clear
	Post					0.0044			Clear
227	Pre	54.4	44.7	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post					0.0042			Clear
228	Pre	54.4	44.7	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post					0.0063			Clear

△1 Particulate = 0.5 mg/liter

TABLE V (2 of 2)

Test No.	Time	HNO_3 (wt %)	NTO (wt %)	H_2O (wt %)	HF (wt %)	Fe_2O_3 (wt %)	M_2O_3 (wt %)	TN (wt %)	Physical Appearance
229	Pre	53.4	45.7	0.2	0.7	<0.0001	0.0007	0.003	Clear
	Post					0.0061			Clear
230	Pre	53.4	45.7	0.2	0.7	<0.0001	0.0007	0.003	Clear
	Post					0.0033	0.0076		Clear
231	Pre	53.4	45.7	0.2	0.7	<0.0001	0.0007	0.003	Clear
	Post					0.0046	0.0066		Many Particles
232	Pre	53.4	45.7	0.2	0.7	<0.0001	0.0007	0.003	Clear
	Post					0.0069	0.0153		Clear

TABLE VI

CORROSION TEST RESULTS - 7 DAYS AT 120°F (1 of 3)

Test No.	Material	Source	NTO	HF △1	H_2O △2	Metals: Physical Appearance: Vapor △3	Metals: Physical Appearance: Liquid △3	Metals: Corrosion Rate (Mils/Year): Vapor	Metals: Corrosion Rate (Mils/Year): Liquid	Acid: Phys. App. △3	Acid: Δ Wt %: M_2O_3	Acid: Δ Wt %: Fe_2O_3	Deposits (mg): Vapor △3	Deposits (mg): Liquid △3	S/V ($in.^{-1}$)	Rating (Refer To Table II)
185	347/AM350 TIG Weld	Airesearch	Gn Gn	Med	Lo	---	White Corrosion Products in the bellows; AM 350 welds were etched (7)	---	3.1	>p (5)	---	0.0050	---	60.5 (2)	1.0	AM350 III
186	ARMCO 21-6-9	Airesearch	Gn Gn	Med	Lo	Light Green Corrosion Products on faces, White Corrosion Products in hole, No effect on metal (7)	Light Green Corrosion Products; No effect on metal (7)	0.5	2.2	>p (5)	---	0.0073	11.8 (5)	7.6 (5)	1.0	III
188	Cr plated 440C	Airesearch	Gn Gn	Med	Lo	---	Flaking of plating (3)	---	---	Clear (1)	---	0.0046	---	30.1 (1)	1.0	IV
189	Pt-Co Alloy	Airesearch	Gn Gn	Med	Lo	---	Blue-Black Color, Some attack (4)	---	0.8	Clear (1)	0.0024	---	---	0.6 (11)	0.1	I
190	316 ELC	Airesearch	Gn Gn	Med	Lo	Gray Stains; No effect on metal (3)	Light Green Corrosion Products; No effect on metal (7)	0.6	2.5	Clear (1)	---	0.0050	24.4 (1)	11.8 (5)	1.0	II
191	NITUFF on 6061 Al	Airesearch	Gn Gn	Med	Lo	---	Irridescent, Some attack on metal (2)	---	---	OK (3)	---	---	---	8.3 (1)	1.0	II
192	440C	Airesearch	Gn Gn	Med	Lo	White Corrosion Products; Pits. Etched (8)	White Corrosion Products; Pits; Etched (0)	1.6	4.3	Clear (1)	---	0.0023	3.7 (2)	7.2 (2)	1.0	III
195	Rulon LD	Airesearch	Gn Gn	Med	Lo	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4
196	Rulon 123	Airesearch	Gn Gn	Med	Lo	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4
197	Kel-F 81	Airesearch	Gn Gn	Med	Lo	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4
198	Haynes-25 Screen	Bell Aerospace	Gn Gn	Med	Lo	---	No effect on metal (1)	---	3.8	Clear (1)	---	0.0002	---	0.1 (1)	1.0	II
200	17-7-PH RH 950	Airesearch	Gn Gn	Med	Lo	White Corrosion Products, Etched (7)	White Corrosion Products, Etched (7)	0.7	2.5	Clear (1)	---	0.0070	19.7 (2)	15.2 (2)	1.0	II

△1 Med = 0.4 to 0.8 Weight-Percent
△2 Lo = <0.5 Weight-Percent
△3 = Numbers in parentheses refer to applicable computer code. Refer to Table VII for definition
△4 = Refer to sheet 3 of 3 for test results applicable to nonmetals

TABLE VI (2 of 3)

Test No.	Material	Source	NTO	HF $\triangle$1	H_2O $\triangle$2	Metals: Physical Appearance: Vapor $\triangle$3	Metals: Physical Appearance: Liquid $\triangle$3	Metals: Corrosion Rate (Mils/Year): Vapor	Metals: Corrosion Rate (Mils/Year): Liquid	Acid: Phys. App. $\triangle$3	Acid: Δ Wt %: M_2O_3	Acid: Δ Wt %: Fe_2O_3	Deposits (mg): Vapor $\triangle$3	Deposits (mg): Liquid $\triangle$3	S/V (in.$^{-1}$)	Rating (Refer To Table II)
201	17-7 PH RH 1050	Airesearch	Gn Gn	Med	Lo	White Corrosion Products, Etched (7)	White Corrosion Products, Etched (7)	0.7	3.0	Clear (1)	---	0.0062	23.2 (2)	35.0 (2)	1.0	II
226	304L/	Bell Aerospace	Gn Gn	Med	Lo	---	No Effect (1)	---	1.3	Clear (1)	---	0.0008	---	0.7 (1)	1.0 (Total)	II
	Haynes-25 Couple						Etched (5)	---	10.0				---	0.3 (1)		III
226'	304L/	Bell Aerospace	Gn Gn	Med	Lo	---	No Effect (1)	---	1.0	Clear (1)	---	0.0043	---	0	1.0 (Total)	II
	Haynes-25 Couple					---	No Effect (1)	---	2.1				---	0		II
227	347/	Bell Aerospace	Gn Gn	Med	Lo	---	Etched (5)	---	2.4	Clear (1)	---	0.0041	---	8.3 (1)	1.0 (Total)	II
	Cr Plated Worthite Couple					---	No Effect (1)	---	<0.01				---	1.6 (1)		I
228	302/304L Weld	Bell Aerospace	Gn Gn	Med	Lo	---	302 Etched (5)	---	4.4 (Total)	Clear (1)	---	0.0062	---	3.9 (1)	1.0	II
229	17-7 PH Torque Tube	Bell Aerospace	Gn Gn	Med	Lo	---	White Salts in Tube (7)	---	4.4	Clear (1)	---	0.0060	---	3.8 (2)	1.0	II
230	356-T6/	Bell Aerospace	Gn Gn	Med	Lo	White Salts in Crevice of Couple (7)	White Salts in Crevice of Couple (7)	1.9	3.4	Clear (1)	0.0069	0.0032	5.1 (2)	0.6 (2)	1.0 (Total)	II
	304 Couple							5.1	1.9				1.8 (2)	0.5 (2)		II
231	356-T6/	Bell Aerospace	Gn Gn	Med	Lo	White Salts in Crevice of Couple (7)	White Salts in Crevice of Couple (7)	3.4	2.4	>P (3)	0.0059	0.0045	6.7 (2)	5.8 (2)	1.0 (Total)	II
	304L Couple							2.4	0.6				5.7 (2)	5.2 (2)		II
232	Anodized (H_2SO_4) 6061-T6/	Bell Aerospace	Gn Gn	Med	Lo	Anodize OK except for White Salts in Crevice (7)	Anodize OK except for White Salts in Crevice (7)	0.1	3.6	Clear (1)	0.0146	0.0068	7.6 (2)	1.1 (2)	1.0 (Total)	II
	304L Couple					No Effect (1)	No Effect (1)	0.0	0.5				5.5 (Inc. Al salts) (1)	0.4 (1)		I

$\triangle$1 = Med = 0.4 to 0.8 Weight-Percent

$\triangle$2 = Lo = <0.5 Weight-Percent

$\triangle$3 = Numbers in parentheses refer to applicable computer code. Refer to Table VII for definition.

TABLE VI (3 of 3)

Compatibility Test Results - Nonmetals

Test No.	Material	Source	NTO	HF (1)	H_2O (2)	Physical Appearance (3)	Plastic Physical Properties: Weight (Δ %)	Volume (Δ %)	Hardness (Shore D Units)	Width (Δ In.)	Thickness (Δ In.)	Acid: Phys. Appear. (3)	Particulate (mg/liter)	Rating (Refer To Table II)
195	Rulon LD	Airesearch	Gn Gn	Med	Lo	Color change, red to gray (4)	+2.86	+7.29	-2	+0.0083	+0.0069	OK (3)	0.8	II
196	Rulon 123	Airesearch	Gn Gn	Med	Lo	Surface change, smooth to rough (5)	+7.57	+9.03	-6	+0.0103	+0.0062	OK (3)	0.3	II
197	Kel-F 81	Airesearch	Gn Gn	Med	Lo	Color change, white to amber (4)	+1.12	+1.49	-6	+0	+0.0009	OK (3)	0.1	II

(1) Med = 0.4 to 0.8 Weight-Percent

(2) Lo = <0.5 Weight-Percent

(3) Numbers in parentheses refer to applicable computer code. Refer to Table VII for definition.

TABLE VII

HDA CORROSION TEST COMPUTER CODE

Acid		Material (Specify Worst Case)		Corrosion Products (Specify Predominant Color)	
Code	Appearance	Code	Worst Case	Code	Color
(1)	Clear	(1)	N.E. (No Effect)	(1)	Colorless
(2)	Discolored	(2)	Iridescent	(2)	White
(3)	O.K.	(3)	Streaks	(3)	Violet
(4)	Particles	(4)	Discolored or Disfigured	(4)	Indigo
(5)	Many Particles >P	(5)	Etched	(5)	Green
(6)	Cloudy	(6)	Severe Etch	(6)	Blue
		(7)	Corrosion Products	(7)	Yellow
		(8)	Pits	(8)	Orange
		(9)	Plating Flakes	(9)	Brown
		(10)	No Inhibition	(10)	Red
				(11)	Black

TABLE VIII

ACIDS FOR BAC SPONSORED CORROSION TESTS AT 120°F

Test No.	Material	Source	NTO	H_2O ⚠1	HF ⚠2	Time (days)	Temp. (°F)	Acid Type	NTO	HF Type	H_2O Added
182	5454 H-32 Al	Fruehauf	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
183	5454 H-32 Al Welded	Fruehauf	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
184	5454-0 Al	Fruehauf	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
193	5086 Al	Fruehauf	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
194	5086 Al Welded	Fruehauf	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No
154	6061 T-6 Al	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-R	LM-F	Cyl.	No
153	6061 T-6 Al Welded	Bell Aerospace	Gn Gn	Lo	Med	7	120	WFNA-F	LM-F	Cyl.	No
190	316 ELC	Airesearch	Gn Gn	Lo	Med	7	120	WFNA-H	LM-F	Cyl.	No

⚠1 Lo = <0.5 Weight-Percent

⚠2 Med = 0.4 to 0.8 Weight-Percent

TABLE IX

ACID ANALYSES FOR BAC SPONSORED CORROSION TESTS AT 120°F

Test No.	Time	HNO_3 (wt %)	NTO (wt %)	H_2O (wt %)	HF (wt %)	Fe_2O_3 (wt %)	M_2O_3 (wt %)	TN (wt %)	Physical Appearance
182	Pre	53.5	45.5	0.2	0.7	0.0001	0.0012	0.005	Clear
	Post						0.0014		Clear
183	Pre	53.5	45.5	0.2	0.7	0.0001	0.0012	0.005	Clear
	Post						0.0012		Clear
184	Pre	53.5	45.5	0.2	0.7	0.0001	0.0012	0.005	Clear
	Post						0.0012		OK
193	Pre	54.1	44.9	0.3	0.8	0.0004	0.0012	0.005	Clear
	Post						0.0016		OK
194	Pre	54.1	44.9	0.3	0.8	0.0004	0.0012	0.005	Clear
	Post						0.0017		OK
154	Pre	55.0	44.1	0.1	0.8	0.0003	0.0005	0.002	Clear
	Post						0.0030		Clear
153	Pre	53.1	45.9	0.3	0.7	0.0001	0.0008	0.001	Clear
	Post						0.0034		Clear
190	Pre	53.5	45.5	0.2	0.7	0.0001	0.0012	0.005	Clear
	Post					0.0051			Clear

TABLE X

BAC SPONSORED CORROSION TEST RESULTS - 7 DAYS AT 120°F

Test No.	Material	Source	STO	HF △1	H_2O △2	Metals: Physical Appearance: Vapor △3	Metals: Physical Appearance: Liquid △3	Metals: Corrosion Rate (Mils/Year): Vapor	Metals: Corrosion Rate (Mils/Year): Liquid	Acid: Phys. App. △3	Acid: Δ Wt %: M_2O_3	Acid: Δ Wt %: Fe_2O_3	Deposits (mg): Vapor △3	Deposits (mg): Liquid △3	S/V $(in.^{-1})$	Rating (Refer To Table II)
182	5454 H-32	Fruehauf	Gn Gn	Med	Lo	No Effect (1)	No Effect (1)	< 0.1	0.1	Clear (1)	0.0002	---	0.8 (1)	0.7 (1)	1.0	I
183	5454 H-32	Fruehauf	Gn Gn	Med	Lo	No Effect (1)	No Effect (1)	< 0.1	<0.1	Clear (1)	< 0.0001	---	1.3 (1)	0.6 (1)	1.0	I
184	5454-0	Fruehauf	Gn Gn	Med	Lo	No Effect (1)	No Effect (1)	< 0.1	0.3	OK (3)	< 0.0001	---	1.4 (1)	0.5 (1)	1.0	I
193	5086 Al	Fruehauf	Gn Gn	Med	Lo	No Effect (1)	No Effect (1)	0.1	0.1	OK (3)	0.0004	---	1.5 (1)	1.1 (1)	1.0	I
194	5086 Al Welded	Fruehauf	Gn Gn	Med	Lo	No Effect (1)	No Effect (1)	< 0.1	0.2	OK (3)	0.0005	---	1.6 (1)	1.2 (1)	1.0	I
154	6061 T-6	Bell Aerospace	Gn Gn	Med	Lo	Discolored (4)	No Effect (1)	< 0.1	< 0.1	Clear (1)	0.0025	---	3 (1)	---	1.0	I
153	6061 T-6 Welded	Bell Aerospace	Gn Gn	Med	Lo	Discolored (4)	No Effect (1)	< 0.1	0.2	Clear (1)	0.0026	---	5.2 (1)	2.3 (1)	1.0	I
190	3.1 ELC	Airesearch	Gn Gn	Med	Lo	Gray Stains; No effect on metal (3)	Light Green Corrosion Products on metal (7)	0.6	2.5	Clear (1)	---	0.005	24.4 (1)	11.8 (5)	1.0	II

△1 Med = 0.4 to 0.8 Weight-Percent
△2 Lo = <0.5 Weight-Percent
△3 Numbers in parentheses refer to applicable com- [illegible] code. Refer to Table VII for definition.

TABLE XI

ACIDS FOR CORROSION TESTS AT 220°F

Test No.	Material	Source	NTO	H_2O 1	HF 2	Time (days)	Temp. (°F)	Acid Type	NTO	HF Type	H_2O Added
221	356-T6	Bell Aerospace	Gn Gn	Lo	Med	6	220	WFNA-H	LM-F	Cyl.	No
222	356-T6 Hard Anodized	Bell Aerospace	Gn Gn	Lo	Med	6	220	WFNA-H	LM-F	Cyl.	No
223	304L	Bell Aerospace	Gn Gn	Lo	Med	6	220	WFNA-H	LM-F	Cyl.	No
224	AM350	Bell Aerospace	Gn Gn	Lo	Med	6	220	WFNA-H	LM-F	Cyl.	No
225	Anodized 6061-T6/304L Couple	Bell Aerospace	Gn Gn	Lo	Med	6	220	WFNA-H	LM-F	Cyl.	No

1 Lo = <0.5 Weight-Percent

2 Med = 0.4 to 0.8 Weight-Percent

TABLE XII

ACID ANALYSES FOR CORROSION TESTS AT 220°F

Test No.	Time	HNO_3 (wt %)	NTO (wt %)	H_2O (wt %)	HF (wt %)	Fe_2O_3 (wt %)	M_2O_3 (wt %)	TN (wt %)	Physical Appearance
221	Pre	54.4	44.7	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post						0.0011		Clear
222	Pre	54.4	44.7	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post						0.0024		Many Particles
223	Pre	54.4	44.7	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post					0.0019			Clear
224	Pre	54.4	44.7	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post					0.0011			Clear
225	Pre	54.4	44.7	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post					0.0021	0.0056		One Large Particle

TABLE XIII

CORROSION TEST RESULTS - 6 HOURS AT 220°F

Test No.	Material	Source	NTO	HF △1	H_2O △2	Metals: Physical Appearance: Vapor △3	Metals: Physical Appearance: Liquid △4	Metals: Corrosion Rate (Mils/Year): Vapor	Metals: Corrosion Rate (Mils/Year): Liquid	Acid: Phys. App. △3	Acid: Δ Wt %: M_2O_3	Acid: Δ Wt %: Fe_2O_3	Deposits (mg): Vapor △3	Deposits (mg): Liquid △3	S/V (in.$^{-1}$)	Rating (Refer To Table II)
221	356-T6	Bell Aerospace	Gn Gn	Med	Lo	Discolored-dull (4)	No Effect (1)	2.8	1.4	Clear (1)	0.0006	---	0.1 (1)	0	1.0	II
222	356-T6 Hard Anodized	Bell Aerospace	Gn Gn	Med	Lo	Discolored-blacker (4)	Blenched from black to gray (4)	-550 (Weight and volume increase)	-1106	>P (5)	0.0019	---	6.9 (1)	17.5 (1)	1.0	IV
223	304L	Bell Aerospace	Gn Gn	Med	Lo	No Effect (1)	No Effect (1)	1.6	2.4	Clear (1)	---	0.0018	1.8 (1)	2.8 (1)	1.0	II
234	AM 350	Bell Aerospace	Gn Gn	Med	Lo	Discolored (4)	No Effect (1)	5.0	16.0	Clear (1)	---	0.0010	8.8 (1)	21.1 (1)	1.0	III
225	Anodized 6061-T6/		Gn Gn	Med	Lo	Anodize Removed in Crevice (5)	Anodize Removed in Crevice (5)	1.3	5.0	One Large Particle (4)	0.0051	0.0020	4.7 (1)	18.5 (1)	1.0 (Total)	II
	304L Couple	Bell Aerospace				No Effect (1)	No Effect (1)	0.6	0.6				4.7 (1)	9.3 (1)		I

△1 Med = 0.4 to 0.8 Weight-Percent

△2 Lo = <0.5 Weight-Percent

△3 Numbers in parentheses refer to applicable computer code. Refer to Table VII for definition.

TABLE XIV

ACIDS FOR CORROSION TESTS AT 90°F (1 of 2)

Test No.	Material	Source	NTO	H_2O (1)	HF (2)	Time (days)	Temp. (°F)	Acid Type	NTO	HF Type	H_2O Added
203	6061-T6	Bell Aerospace	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
204	347 SS	Bell Aerospace	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
205	Columbium C-103 (W R512E Coat)	TRW	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
206	17-7 PH Full Annealed (Condition A)	TRW	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
207	Au/Ni Braze Alloy	LMSC	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
208	17-7 PH RH 1050	LMSC	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
209	Rulon A	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
210	AM350 Screen	LMSC	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
211	304L	LMSC	Gn Gn	Lo	Med	50	90	WFNA-H	LM-F	Cyl.	No
212	321/321 Bellows-Welded	LMSC	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
214	321/321-347 Filler-Weld	LMSC	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
215	304/304-308 Filler-Weld	LMSC	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
216	356A Cast	LMSC	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
217	356-T6	Bell Aerospace	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
218	321	LMSC	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
219	304L Work Hardened	TRW	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
220	25% Glass Filled Teflon	LMSC	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
233	Kel-F 5500	Bell Aerospace	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
234	Kel-F 81	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
235	Rulon LD	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
236	Rulon 123	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No

(1) Lo = <0.5 weight-percent

(2) Med = 0.4 to 0.8 weight + percent

TABLE XIV (2 of 2)

Test No.	Material	Source	NTO	H_2O (1)	HF (2)	Time (days)	Temp. (°F)	Acid Type	NTO	HF Type	H_2O Added
237	17-7 PH Torque Tube	Bell Aerospace	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
238	304L	Bell Aerospace	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
239	440C	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
240	Armco 21-6-9	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
241	20-Cb-3	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
242	Chromized Haynes - 25	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
243	Chromized 440C	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
244	2021/2021 Weld	LMSC	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
245	2219/2219 Weld	LMSC	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
246	M-50 Alloy	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No.
247	316 Spring Wire	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
248	17-4 PH H 1025	LMSC	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
249	17-7 PH Spring Wire	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
250	Rh plated Haynes - 25	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-H	LM-F	Cyl.	No
251	Rh plated 440C	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
252	MP-35-N	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
253	304L/304L Tig Weld	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No
254	347/347 Tig Weld	Airesearch	Gn Gn	Lo	Med	60	90	WFNA-I	LM-F	Cyl.	No

(1) Lo = <0.5 weight - percent

(2) Med = 0.4 to 0.8 weight - percent

TABLE XV

ACID ANALYSES FOR CORROSION TESTS AT 90°F (1 of 3)

Test No.	Time	HNO_3 (wt %)	NTO (wt %)	H_2O (wt %)	HF (wt %)	Fe_2O_3 (wt %)	M_2O_3 (wt %)	TN (wt %)	Physical Appearance
203	Pre Post	55.6	43.5	0.2	0.7	0.0002	0.0006 0.0014	0.010	Clear A few particles
204	Pre Post	55.6	43.5	0.2	0.7	0.0002 0.0039	0.0006	0.010	Clear Clear
205	Pre Post	55.6	43.5	0.2	0.7	0.0002	0.0006 0.6985	0.010	Clear Dark green, cloudy
206	Pre Post	55.6	43.5	0.2	0.7	0.0002 0.0035	0.0006 0.0147	0.010	Clear Clear
207	Pre Post	55.6	43.5	0.2	0.7	0.0002	0.0006 0.5178	0.010	Clear Light green liquid
208	Pre Post	55.6	43.5	0.2	0.7	0.0002 0.0011	0.0006 0.0577	0.010	Clear Clear
209	Pre Post	55.6	43.5	0.2	0.7	0.0002	0.0006	0.010	Clear Clear △1
210	Pre Post	55.6	43.5	0.2	0.7	0.0002 0.0009	0.0006	0.010	Clear Clear
211	Pre Post	55.6	43.5	0.2	0.7	0.0002 0.0037	0.0006	0.010	Clear Clear
212	Pre Post	53.7	45.3	0.2	0.8	0.0001 0.0016	0.0007	0.010	Clear Many large particles
213	Pre Post	53.7	45.3	0.2	0.8	0.0001	0.0007 0.5177	0.010	Clear Many particles
214	Pre Post	53.7	45.3	0.2	0.8	0.0001 0.0021	0.0007	0.010	Clear Many fine particles
215	Pre Post	53.7	45.3	0.2	0.8	0.0001 0.0034	0.0007	0.010	Clear Many fine particles
216	Pre Post	53.7	45.3	0.2	0.8	0.0001	0.0007 0.0020	0.010	Clear Clear
217	Pre Post	53.7	45.3	0.2	0.8	0.0001	0.0007 0.0016	0.010	Clear A few particles
218	Pre Post	53.7	45.3	0.2	0.8	0.0001 0.0023	0.0007	0.010	Clear Many fine particles
219	Pre Post	53.7	45.3	0.2	0.8	0.0001 0.0054	0.0007	0.010	Clear Many fine particles
220	Pre Post	53.7	45.3	0.2	0.8	0.0001	0.0007	0.010	Clear OK △2

△1 Particulate = 0.1 mg/liter

△2 Particulate = 3.3 mg/liter

TABLE XV (2 of 3)

Test No.	Time	HNO_3 (wt %)	NTO (wt %)	H_2O (wt %)	HF (wt %)	Fe_2O_3 (wt %)	M_2O_3 (wt %)	TN (wt %)	Physical Appearance
233	Pre	53.4	45.7	0.2	0.7	0.0001	0.0007	0.003	Clear
	Post								Clear [1]
234	Pre	53.4	45.7	0.2	0.7	0.0001	0.0007	0.003	Clear
	Post								Clear [1]
235	Pre	53.4	45.7	0.2	0.7	0.0001	0.0007	0.003	Clear
	Post								Clear [1]
236	Pre	53.4	45.7	0.2	0.7	0.0001	0.0007	0.003	Clear
	Post								Clear [3]
237	Pre	53.4	45.7	0.2	0.7	0.0001	0.0007	0.003	Clear
	Post					0.0042			Clear
238	Pre	53.7	45.4	0.2	0.8	0.0002	0.0008	0.010	Clear
	Post					0.0061			Clear
239	Pre	53.7	45.4	0.2	0.8	0.0002	0.0008	0.010	Clear
	Post					0.0061			Many fine particles
240	Pre	53.7	45.4	0.2	0.8	0.0002	0.0008	0.010	Clear
	Post					0.0056			Many large particles
241	Pre	53.7	45.4	0.2	0.8	0.0002	0.0008	0.010	Clear
	Post					0.0009			Many fine particles
242	Pre	53.7	45.4	0.2	0.8	0.0002	0.0008	0.010	Clear
	Post						0.2721		Dark, green, black liquid
243	Pre	53.7	45.4	0.2	0.8	0.0002	0.0008	0.010	Clear
	Post						18.4916		Dark, green, black liquid
244	Pre	53.7	45.4	0.2	0.8	0.0002	0.0008	0.010	Clear
	Post						0.0440		Many particles
245	Pre	53.7	45.4	0.2	0.8	0.0002	0.0008	0.010	Clear
	Post						0.0311		Many particles
246	Pre	53.4	45.7	0.2	0.7	0.0002	0.0007	0.003	Clear
	Post					0.0066			Many particles
247	Pre	54.4	44.6	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post					0.0048			Clear
248	Pre	54.4	44.6	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post					0.0071			Clear
249	Pre	54.4	44.6	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post					0.0045			Clear

[1] Particulate = 0.1 mg/liter

[3] Particulate = 0.2 mg/liter

TABLE XV (3 of 3)

Test No.	Time	HNO_3 (wt %)	NTO (wt %)	H_2O (wt %)	HF (wt %)	Fe_2O_3 (wt %)	M_2O_3 (wt %)	TN (wt %)	Physical Appearance
250	Pre	54.4	44.6	0.2	0.7	0.0001	0.0005	0.010	Clear
	Post						0.5720		Dark red liquid, many particles
251	Pre	53.8	45.3	0.2	0.7	0.0001	0.0004	0.010	Clear
	Post						0.4640		Green liquid, many particles
252	Pre	53.8	45.3	0.2	0.7	0.0001	0.0004	0.010	Clear
	Post						0.3780		Darkened liquid, many particles
253	Pre	53.8	45.3	0.2	0.7	0.0001	0.0004	0.010	Clear
	Post					0.0021			Many, many, fine and large particles
254	Pre	53.8	45.3	0.2	0.7	0.0001	0.0004	0.010	Clear
	Post					0.0015			Many, many large particles

TABLE XVI

CORROSION TEST RESULTS - 60 DAYS AT 90°F (1 of 5)

Test No.	Material	Source	STO	HF △1	H_2O △2	Metals: Physical Appearance: Vapor △3	Metals: Physical Appearance: Liquid △3	Metals: Corrosion Rate (Mils/Year): Vapor	Metals: Corrosion Rate (Mils/Year): Liquid	Acid: Phys. App. △3	Acid: Δ Wt %: M_2O_3	Acid: Δ Wt %: Fe_2O_3	Deposits (mg): Vapor △3	Deposits (mg): Liquid △3	S/V ($in.^{-1}$)	Rating (Refer To Table II)
203	6061-T6	Bell Aerospace	Gn Gn	Med	Lo	Slight Tarnish (4)	Slight Tarnish (4)	< 0.1	< 0.1	OK (3)	0.0008	---	0.3 (1)	0.2 (1)	1.0	I
204	347 SS	Bell Aerospace	Gn Gn	Med	Lo	White Corrosion Products. No effect on metal (7)	Dull (4)	0.2	0.6	Clear (1)	---	0.0037	23.1 (2)	3.7 (1)	1.0	I
205	Cb C-103 (W R512E Coat)	TRW	Gn Gn	Med	Lo	---	Green Corrosion Products; metal etched (7)	---	11.0	Dark Green, Cloudy (6)	0.6979	---	---	32.8 (5)	1.0	III
206	17-7 PH Full Annealed (Condition A)	TRW	Gn Gn	Med	Lo	---	White Corrosion Products; metal etched (7)	---	0.7	Clear (1)	0.0141	0.0033	---	11.0 (2)	1.0	I
207	Au/Ni Braze Alloy	LMSC	Gn Gn	Med	Lo	---	Severely etched (6)	---	10.0	Clear Green Liquid (2)	0.5172	---	---	17.0 (1)	1.0	III
208	17-7 PH RH 1050	LMSC	Gn Gn	Med	Lo	---	Green Corrosion Products; pits, etched (8)	---	0.8	Clear (1)	0.0571	0.0009	---	64.3 (5)	1.0	II
209	Rulon A	Airesearch	Gn Gn	Med	Lo	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4
210	AM 350 Screen	LMSC	Gn Gn	Med	Lo	Green Corrosion Products No effect on metal (7)	Green Corrosion Products:No effect on metal (7)	0.4	1.0	Clear (1)	---	0.0007	78.6 (5)	50.7 (5)	1.0	II
211	304L	LMSC	Gn Gn	Med	Lo	Green Corrosion Products; No effect on metal (7)	No Effect (1)	0.3	0.5	Clear (1)	---	0.0035	50.4 (5)	9.3 (1)	1.0	I
212	321/321 Welded Bellows	LMSC	Gn Gn	Med	Lo	White Corrosion Products, HAZ and tack welds etched (7)	White Corrosion Products; HAZ and tack welds etched (7)	0.6	1.4	>P (5)	---	0.0015	302 (2)	134 (2)	1.0	II

△1 Med 0.4 to 0.8 Weight-Percent

△2 Lo <0.5 Weight-Percent

△3 Numbers in parentheses refer to applicable computer code. Refer to Table VII for definition.

△4 Refer to sheet 5 of 5 for test results applicable to nonmetals.

TABLE XVI (2 of 5)

Test No.	Material	Source	NTO	HF △1	H_2O △2	Metals: Physical Appearance: Vapor △3	Metals: Physical Appearance: Liquid △3	Metals: Corrosion Rate (Mils/Year): Vapor	Metals: Corrosion Rate (Mils/Year): Liquid	Acid: Phys. App. △3	Acid: Δ Wt %: M_2O_3	Acid: Δ Wt %: Fe_2O_3	Deposits (mg): Vapor △3	Deposits (mg): Liquid △3	S/V ($in.^{-1}$)	Rating (Refer To Table II)
214	321/321-347 Filler Weld	LMSC	Gn Gn	Med	Lo	White Corrosion Products, Cut end attack (7)	White Corrosion Products: Cut end attack (7)	0.3	0.8	>P (5)	---	0.0020	41 (2)	33 (2)	1.0	II
215	304/304-308 Filler Weld	LMSC	Gn Gn	Med	Lo	Light Green Corrosion Products: end grain attack (7)	Light Green Corrosion Products: end grain attack (7)	0.2	0.7	>P (5)	---	0.0033	53 (5)	43 (5)	1.0	II
216	355 A Cast	LMSC	Gn Gn	Med	Lo	Discolored - black (4)	Discolored (4)	0.1	0.2	Clear (1)	0.0013	---	1 (11)	17 (1)	1.0	I
217	356-T6	Bell Aerospace	Gn Gn	Med	Lo	Discolored (4)	No Effect (1)	0.2	0.5	OK (3)	0.0009	---	4 (1)	7 (1)	1.0	I
218	321	LMSC	Gn Gn	Med	Lo	Green Corrosion Products (7)	Metal etched (5)	0.4	0.9	>P (5)	---	0.0022	58 (5)	104 (1)	1.0	II
219	304L Work Hardened	TRW	Gn Gn	Med	Lo	---	Etched (5)	---	0.5	>P (5)	—	0.0053	---	0.2 (1)	1.0	II
220	25% Glass Filled Teflon	LMSC	Gn Gn	Med	Lo	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4
233	Kel-F 5500	Bell Aerospace	Gn Gn	Med	Lo	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4
234	Kel-F 81	Airesearch	Gn Gn	Med	Lo	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4
235	Rulon LD	Airesearch	Gn Gn	Med	Lo	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4
236	Rulon 123	Airesearch	Gn Gn	Med	Lo	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4	△4
237	17-7 PH Torque Tube	Bell Aerospace	Gn Gn	Med	Lo	---	Light Green Corrosion Products (7)	---	0.7	Clear (1)	---	0.0041	---	1.0 (5)	1.0	I
238	304L	Bell Aerospace	Gn Gn	Med	Lo	White Corrosion Products (7)	No Effect (1)	0.2	0.5	Clear (1)	---	0.0059	22.7 (2)	3.1 (1)	1.0	I
239	440C	Airesearch	Gn Gn	Med	Lo	White Corrosion Products; etched, pits (8)	White Corrosion Products; etched (7)	1.2	1.7	>P (5)	---	0.0059	200.0 (2)	266.0 (2)	1.0	II

△1 Med = 0.4 to 0.8 Weight-Percent
△2 Lo = <0.5 Weight-Percent
△3 Numbers in parentheses refer to applicable computer code. Refer to Table VII for definition.
△4 Refer to sheet 5 of 5 for test results applicable to nonmetals.

TABLE XVI (3 of 5)

Test No.	Material	Source	NTO	HF △1	H_2O △2	Metals: Physical Appearance – Vapor △3	Metals: Physical Appearance – Liquid △3	Metals: Corrosion Rate (Mils/Year) – Vapor	Metals: Corrosion Rate (Mils/Year) – Liquid	Acid: Phys. App. △3	Acid: Δ Wt % – M_2O_3	Acid: Δ Wt % – Fe_2O_3	Deposits (mg) – Vapor △3	Deposits (mg) – Liquid △3	S/V ($in.^{-1}$)	Rating (Refer To Table II)
240	ARMCO 21-6-9	Airesearch	Gn Gn	Med	Lo	Yellow Corrosion Products (7)	Yellow Corrosion Products (7)	0.1	0.4	>P (5)	---	0.0054	39.0 (7)	10.0 (7)	1.0	II
241	20-Cb-3	Airesearch	Gn Gn	Med	Lo	Green Corrosion Products; metal etched (7)	White Corrosion Products (7)	0.2	0.5	>P (5)	---	0.0007	25.0 (5)	1.0 (2)	1.0	II
242	Chromized Haynes-25	Airesearch	Gn Gn	Med	Lo	Red, Black, and Green Corrosion Products; coating removed (9)	White Corrosion Products; coating removed (9)	1.7	2.4	Dark green liquid (2)	0.2713	---	71.0 (11)	48.0 (2)	1.0	III
243	Chromized 440C	Airesearch	Gn Gn	Med	Lo	Green Corrosion Products; coating removed (9)	Coating removed; metal severely etched (10)	3.6	1112.0	Dark green liquid (2)	18.49	---	291.0 (5)	288.0 (11)	1.0	IV
244	2021/2021 Weld	LMSC	Gn Gn	Med	Lo	White Corrosion Products; cavities on weld (7)	White Corrosion Products; attack on weld and HAZ (7)	0.3	0.5	>P (5)	0.0432	---	48.0 (2)	14.0 (2)	1.0	II
245	2219/2219 Weld	LMSC	Gn Gn	Med	Lo	No Effect (1)	White Corrosion Products; attack on weld and HAZ (7)	0.4	0.4	>P (5)	0.0303	---	38.0 (2)	2.0 (1)	1.0	II
246	M-50 Alloy	Airesearch	Gn Gn	Med	Lo	White Corrosion Products (7)	White Corrosion Products (7)	0.8	1.3	>P (5)	---	0.0065	118.0 (2)	206.0 (2)	1.0	II
247	316 Spring Wire	Airesearch	Gn Gn	Med	Lo	White Corrosion Products (7)	Etched (5)	0.2	0.6	Clear (1)	---	0.0047	11.9 (2)	1.0 (1)	1.0	I
248	17-4 PH H 1025	LMSC	Gn Gn	Med	Lo	White Corrosion Products; metal mottled and etched (7)	Yellow Corrosion Products; etched (7)	0.2	0.9	Clear (1)	---	0.0070	44.0 (2)	30.0 (7)	[illegible]	I

△1 Med - 0.4 to 0.8 Weight-Percent

△2 Lo " <0.5 Weight-Percent

△3 Numbers in parentheses refer to applicable computer code. Refer to Table VII for definition.

TABLE XVI (4 of 5)

Test No.	Material	Source	NTO	HF [1]	H_2O [2]	Metals: Physical Appearance: Vapor [3]	Metals: Physical Appearance: Liquid [3]	Metals: Corrosion Rate (Mils/Year): Vapor	Metals: Corrosion Rate (Mils/Year): Liquid	Acid: Phys. App. [3]	Acid: Δ Wt %: M_2O_3	Acid: Δ Wt %: Fe_2O_3	Deposits (mg): Vapor [3]	Deposits (mg): Liquid [3]	S/V ($in.^{-1}$)	Rating (Refer To Table II)
249	17-7 PH Spring Wire	Airesearch	Gn Gn	Med	Lo	White Corrosion Products (7)	Etched (5)	0.3	<0.1	Clear	---	0.0044	4.0 (2)	<1.0 (1)	1.0	I
250	Rh plated Haynes-25	Airesearch	Gn Gn	Med	Lo	---	Green Corrosion Products; plate broken thru (9)	---	4.8	Dark red liquid >p (5)	0.5713	---	---	54.0 (5)	1.0	III
251	Rh plated 440C	Airesearch	Gn Gn	Med	Lo	---	White Corrosion Products, plate broken thru (9)	---	4.7	Green liquid >p (5)	0.4636	---	---	309.0 (2)	1.0	III
252	MP-35-N	Airesearch	Gn Gn	Med	Lo	Brown Corrosion Products (7)	Etched (5)	0.4	1.8	Dark red liquid >p (5)	0.3776	---	9.0 (9)	0.3 (1)	1.0	II
253	304L/304L TIG Weld	Airesearch	Gn Gn	Med	Lo	White Corrosion Products in crevice (7)	White Corrosion Products in crevice (7)	0.2	0.8	>p (5)	---	0.0020	64.0 (2)	113.0 (2)	1.0	II
254	347/347 TIG Weld	Airesearch	Gn Gn	Med	Lo	White Corrosion Products in crevice (7)	White Corrosion Products in crevice (7)	0.1	0.9	>p (5)	---	0.0014	48.0 (2)	60.0 (2)	1.0	II

[1] Med = 0.4 to 0.8 Weight-Percent

[2] Lo = <0.5 Weight-Percent

[3] Numbers in parentheses refer to applicable computer code. Refer to Table VII for definition.

TABLE XVI (5 of 5)

Compatibility Test Results - Nonmetals														
							Plastic Physical Properties					Acid		
Test No.	Material	Source	NTO	HF △1	H_2O △2	Physical Appearance △3	Weight (Δ %)	Volume (Δ %)	Hardness Δ Shore D Units	Width (Δ In.)	Thickness (Δ In.)	Phys. Appear. △3	Particulate (mg/liter)	Rating (Refer To Table II)
209	Rulon A	Airesearch	Gn Gn	Med	Lo	Color change, red to white (4)	+ 4.2(V) + 5.6(L)	+10.2(V) +10.2(L)	+ 4(V) + 3(L)	+0.0106(V) +0.0067(L)	+0.0039(V) +0.0036(L)	Clear (1)	1.0	II
220	25% Glass Filled Teflon	LMSC	Gn Gn	Med	Lo	Color change, yellow to white (4)	+ 5.2(V) + 7.2(L)	+ 6.5(V) +12.8(L)	- 2(V) - 2(L)	--- ---	+0.003 (V) +0.003(L)	Clear (1)	3.3	II
233	Kel-F 5500	Bell Aerospace	Gn Gn	Med	Lo	Spongy and swollen (4)	-28.3(V) -12.2(L)	+12.2(V) + 7.6(L)	-30(V) △5 -30(L) △5	--- ---	+0.083 (V) +0.086 (L)	Clear (1)	0.1	III
234	Kel-F 81	Airesearch	Gn Gn	Med	Lo	Color change, transparent to yellow (4)	+ 0.4(V) + 0.5(L)	+ 0.3(V) + 0.5(L)	0 (V) 0 (L)	+0.0007(V) +0.0005(L)	-0.002 (V) -0.001 (L)	Clear (1)	0.1	II
235	Rulon LD	Airesearch	Gn Gn	Med	Lo	Color change, red to gray; white salts from filler, retains acid (4)	+ 4.6(V) + 5.2(L)	+14.1(V) +29.9(L)	- 3(V) - 3(L)	+0.013 (V) +0.005 (L)	+0.006 (V) +0.006 (L)	Clear (1)	0.1	III
236	Rulon 123	Airesearch	[illegible]	Med	Lo	No effect; retains acid (1)	+ 8.2(V) + 8.7(L)	+ 7.3(V) +10.6(L)	- 3(V) - 3(L)	+0.016 (V) +0.015 (L)	+0.006 (V) +0.005 (L)	Clear (1)	0.2	I

△1 Med = 0.4 to 0.8 Weight-Percent

△2 Lo = <0.5 Weight Percent

△3 Numbers in parentheses refer to applicable computer code. Refer to Table VII for definition.

△5 Shore A - Material too soft for Shore D

(V) = Vapor

(L) = Liquid

TABLE XVII

NON-ROUTINE ANALYSES (1 of 2)

Test No.	Material	Particulate (mg/liter)	Film Analyses		Non-Volatile Residue By Emission Spectrograph	Other	Metallo-graphic Analyses
			By EMP	Spectroscopic			
30 Day Tests, 120°F							
191	NITUFF on 6061 Al	0.5	---	---	---	---	---
195	Rulon LD	0.8	---	---	---	---	---
196	Rulon 123	0.3	---	---	---	---	---
197	Kel-F-81	0.1	---	---	---	---	---
6 Hour Tests, 220°F							
224	AM350	---	---	---	---	---	General, even surface attack (Reference 2)
60 Day Tests, 90°F							
205	Columbium C-103 (W R512E Coat)	---	---	---	Cb, Fe, Cr, Ni, Ti, Zr	---	Most of coating removed, diffusion layer intact, edges pitted (Reference 3)
206	17-7PH FACOND A	---	---	---	Fe, Cr, Ni	---	---
207	Au/Ni Braze Alloy	---	---	---	---	59.0 WT % Ni IN NVR	---
208	17-7PH RH 1050	---	---	---	Fe, Cr, Ni	---	Pitting at grain boundaries (Reference 3)
210	AM350-Screen	---	---	---	---	Specimen Identification	---
211	304 (L)	---	---	---	---	Specimen Identification	---
212	321/321 Welded Bellows (Liquid Phase Sample)	---	---	---	---	---	HAZ (Heat Affected Zone) and Tack Welds Attacked (Reference 3)
214	321/321-308 Filler-Weld (Liquid Phase Sample)	---	---	---	---	---	Smeared metal on cut ends attacked (Reference 3)
215	304/304-308 Filler-Weld (Liquid Phase Sample)	---	---	---	---	Specimen Identification	Attack at end grain inclusions (Reference 3)
220	25% Glass-Filled Teflon	3.3	---	---	---	Si In Particulate	---
237	17-7 PH Torque	---	Fe, Cr, Ni, Mn, Al: F, S, Cl	---	---	---	---
238	304L	---	Fe, Cr, Ni, Mn: F	---	---	---	---
240	ARMCO 21-6-9	---	Fe, Cr, Ni, Mn: F	---	---	---	---

Refer to Section VI for References

TABLE XVII (2 of 2)

Test No.	Material	Particulate (mg/liter)	Film Analyses: By EMP	Film Analyses: Spectroscopic	Non-Volatile Residue By Emission Spectrograph	Other	Metallographic Analyses
60 Day Tests, 90°F, (cont)							
242	Chromized Haynes-25	---	Co,Fe,Cr,Ni: F	Co,Fe,Cr,Ni,W	Co,Fe,Cr,Ni,W	---	---
244	2021/2021-Weld (Liquid and vapor phase samples)	---	---	---	---	---	For liquid phase sample: Grain boundaries of weld and HAZ attacked; For vapor phase sample: Welding pores (Reference 3)
245	2219/2219-Weld (Liquid phase sample)	---	Al,Cu,Mn: F	---	---	---	Grain boundaries of weld and HAZ attacked (Reference 3)
246	M-50 Alloy	---	Fe,Cr : F?	---	---	F^- in film	---
250	Rh plated Haynes-25	---	Rh,Cr,Cu, Mn Ni,Si	Ni,Co	Rh,Cr,Ni,Co W,Fe	No F^- in film	Most of plate removed, little attack on substrate (Reference 3)
251	Rh plated 440C	---	---	---	Rh (?),Cr,Cu, Fe,Al	---	All of plate removed, light attack on substrate (Reference 3)
252	MP-35-N	---	---	---	Ni,Co,Cr,Mo	---	---
254	347/347-TIG Weld	---	Fe,Cr :F	Fe,Cr,Ni	Fe,Cr,Ni	---	---

Refer to Section VI for References

TABLE XVIII

HDA COMPATABILITY TESTS

Material	Time	Temp (°F)	Changes In Acid: Physical Appearance	Changes In Acid: Composition	Changes In Acid: Others	Changes In Material: Physical Appearance	Changes In Material: Wt %	Changes In Material: Vol. %	Changes In Material: Hardness (Shore D) Units	Rating (Refer to Table II)
FP Rubber	1 Hour	70	None	---	---	Losing Carbon	---	---	---	II
	16 Hours	70	Discolored	---	Black Particles	Tacky, Inelastic, Deformed	---	---	---	IV
Teflon - TFE	3 Days	70	None	-1% NO_2	IR Neg. for	Tan	1.1	1.0	-21	IV
	After Outgas				Halocarbon	Light Tan	0.3	0.2	-18	IV
	7 Days	70	None	-2% NO_2	IR Neg. for	Tan	1.4	1.5	-23	IV
	After Outgas				Halocarbon	Light Tan	0.5	0.4	-17	IV
	3 Days	100	None	-3% NO_2	IR Neg. for	Tan	1.4	1.7	-22	IV
	After Outgas				Halocarbon	Light Tan	0.5	0.4	-18	IV
Kel-F 5500	3 Days	70	None	-1% NO_2	IR Neg. for	Tan	0.1	0.1	24	IV
	After Outgas				Halocarbon	Light Tan	< 0.1	< 0.1	19	IV
	7 Days	70	None	-2% NO_2	IR Neg. for	Tan	0.1	< 0.1	20	IV
	After Outgas				Halocarbon	Light Tan	< 0.1	< 0.1	15	IV
	3 Days	100	None	-3% NO_2	IR Neg. for	Tan	0.1	0.2	18	IV
	After Outgas				Halocarbon	Light Tan	< 0.1	0.1	15	IV
Rulon LD	7 Days	120	OK	---	0.8 mg Particulate/liter	Color Change Red to Grey	2.9	7.3	-2	II
Rulon 123	7 Days	120	OK	---	0.3 mg Particulate/liter	Surface Change Smooth to Rough	7.6	9.0	-6	II
Kel-F 81	7 Days	120	OK	---	0.1 mg Particulate/liter	Color Change White to Amber	1.1	1.5	-0	II

TABLE XIX

COMPATABILITY OF VARIOUS METALS WITH STANDARD HDA (1 of 3)

Material	Time (Days)	Temp (°F)	S/V (In.$^{-1}$)	Physical Appearance Of Metal		Corrosion Rate (Mils/Year)		Physical Appearance	Δ Wt %		Rating (Refer To Table II)
				Vapor	Liquid	Vapor	Liquid	Acid	M_2O_3	Fe_2O_3	
SAE-52100 Not Hardened	4	120	0.2	---	Discolored	---	1.7	Clear	0.004	0.003	II
440C Not Hardened	7	120	0.5	---	Corrosion Products	---	4.8	Clear	0.005	0.004	II
440C Rockwell C58	7	120	1.0	Pits; Corrosion Products	Pits; Corrosion Products	1.6	4.3	Clear	---	0.002	III
440C Cr Plated	7	120	1.0	---	Plating Flaking	---	---	Clear	---	0.005	IV
AM 350 Bellows	7	120	1.4	---	Corrosion Products	---	1.8	Clear	---	0.003	II
W347/ AM 350	7	120	1.0	---	White Corrosion Products Welds Etched	---	3.1	>P	---	0.005	III
E-Brite 26-1	7	120	1.3	Pits; Discolored	No Effect	4.2	3.1	Clear	0.018	---	III
ARMCO 21-6-9	7	120	1.0	Light Green Corrosion Products	Light Green Corrosion Products	0.5	2.2	>P	---	0.007	III
W302/304	7	120	1.0	---	302 Etched	---	4.4 (total)	Clear	---	0.006	II
304L	7	120	1.0	--- No Effect	No Effect ---	--- 0.6	1.1 ---	Clear P	--- ---	0.005 < 0.001	II II
316 ELC	7	120	1.0	Gray Stains	Light Green Corrosion Products	0.6	2.5	Clear	---	0.005	II
347 Sheet	7	120	1.0	Discolored	Pits Discolored	0.5	3.4	P	---	0.006	III
347 Full Hard	7	120	1.0	No Effect	No Effect	0.5	2.3	>P	---	0.007	III
W347 Sheet	7	120	1.0	Discolored	Discolored	0.8	3.4	>P	---	0.005	III
W347 Bellows	6	120	1.3	---	Pits Discolored	---	2.4	P	---	0.009	III
Worthite	7	120	0.5	---	Etched	---	2.0	Clear	0.013	0.001	II
C347/ Cr Plated Worthite	7	120	1.0 (total)	---	Etched No Effect	--- ---	2.4 < 0.1	Clear	---	0.004	II I
Carpenter-20	7	120	0.1	---	Discolored	---	3.4	Clear	0.005	0.002	II
Nickel	6	120	0.7	---	No Effect	---	190	Discolored	0.299	---	IV
Haynes Star J	7	120	1.0	---	Severe Etch	---	32.6	Discolored	0.402	---	III
Haynes - 25 Bar Stock	7	120	0.6	---	Etched	---	3.3	Discolored	0.089	---	II
Haynes - 25 Screen	7	120	1.0	---	No Effect	---	3.8	Clear	---	< 0.001	II

TABLE XIX (2 of 3)

Material	Time (Days)	Temp. (°F)	S/V ($In.^{-1}$)	Physical Appearance Of Metal: Vapor	Physical Appearance Of Metal: Liquid	Corrosion Rate (Mils/Years): Vapor	Corrosion Rate (Mils/Years): Liquid	Physical Appearance Acid	Δ Wt %: M_2O_3	Δ Wt %: Fe_2O_3	Rating (Refer To Table II)
C Haynes-25/ 304L	7	120	1.0 (total)	--- ---	No Effect No Effect	--- ---	1.0 2.1	Clear	---	0.004	II II
MP 35N	4	120	0.4	---	No Effect	---	5.4	Clear	0.180	---	III
Multimet	7	120	1.0	---	Corrosion Products	---	5.2	>P	0.005	---	III
17-7 PH Torque Tube	7	120	1.0	---	White Corrosion Products in capillary	---	4.4	Clear	---	0.006	II
17-7 PH RH 950	7	120	1.0	White Corrosion Products Etched	White Corrosion Products Etched	.7	2.5	Clear	---	0.007	II
17-7 PH RH 1050	7	120	1.0	White Corrosion Products Etched	White Corrosion Products Etched	0.7	3.0	Clear	---	0.006	II
Al on High-Strength Steel	7	120	0.5	---	No Effect	---	0.5	Clear	0.003	0.003	I
356-Hard Coated	6	120	---	---	No Effect	---	1.8	Clear	0.002	---	II
C356-T6/ 304	7	120	1.0 (total)	White Corrosion Products in Crevice	White Corrosion Products in Crevice	1.9 5.1	3.4	Clear	0.007	0.003	II
C356-T6/ 304L	7	120	1.0 (total)	White Corrosion Products in Crevice	White Corrosion Products in Crevice	3.4 2.4	2.4 0.6	>P	0.006	0.005	II II
2021	7	120	1.0	---	No Effect	---	< 0.1	Clear	0.007	---	I
W2021	7	120	1.0	---	No Effect	---	0.1	Clear	0.003	---	I
2219	7	120	1.0	---	No Effect	---	< 0.1	Clear	0.007	---	I
W2219	7	120	1.0	---	No Effect	---	< 0.1	Clear	0.005	---	I
5083	7	120	1.0	---	No Effect	---	< 0.1	Clear	0.001	---	I
W5083	7	120	1.0	---	No Effect	---	< 0.1	Clear	0.001	---	I
5086	7	120	1.0	No Effect	No Effect	0.1	0.1	OK	< 0.001	---	I
W5086	7	120	1.0	No Effect	No Effect	< 0.1	0.2	OK	< 0.001	---	I
5454-H32	7	120	1.0	No Effect	No Effect	< 0.1	0.1	Clear	< 0.001	---	I
W5454-H32	7	120	1.0	No Effect	No Effect	< 0.1	< 0.1	Clear	< 0.001	---	I
5454-0	7	120	1.0	No Effect	No Effect	< 0.1	0.3	OK	< 0.001	---	I
6061-T6	7	120	1.0	Discolored	No Effect	< 0.1	< 0.1	Clear	0.002	---	I

TABLE XIX (3 of 3)

Material	Time (Days)	Temp. (°F)	S/V ($In.^{-1}$)	Physical Appearance Of Metal		Corrosion Rate (Mils/Years)		Physical Appearance	Δ Wt %		Rating (Refer To Table II)
				Vapor	Liquid	Vapor	Liquid	Acid	M_2O_3	Fe_2O_3	
W6061	7	120	1.0	Discolored	No Effect	< 0.1	0.2	Clear	0.003	---	I
Nituff on 6061	7	120	1.0	---	Irridescent	---	---	OK	---	---	II
C6061-T6 (H_2SO_4) Anodize	7	120	1.0 (total)	Anodize OK except for White Corrosion Products in Crevice	Anodize OK except for White Corrosion Products in Crevice	0.1	3.6	Clear	0.015	0.007	II
304L				No Effect	No Effect	0.6	0.5				I
Beryllium	7	120	0.4	---	Corrosion Products	---	1.9	OK	0.003	---	II
Hafnium Diboride	7	120	1.0	---	Corrosion Products	---	59.5	P	0.509	---	IV
Platinum Cobalt Alloy	7	120	0.1	---	Discolored Blue-Black	---	0.8	Clear	0.002	---	I
Tantalum	7	120	1.0	---	Dissolved	---	---	Clear	0.458	---	IV
Tungsten	2	120	1.1	---	Etched	---	647	>P	2.017	---	IV
Tungsten Carbide	7	120	1.0	---	Corrosion Products	---	1110	P	1.005	---	IV
Cb-1-Zr	6	120	0.8	---	Pits Corrosion Products	---	98.1	>P	0.566	---	IV
SCb-291	7	120	0.6	---	Pits Corrosion Products	---	132	Cloudy	1.502	---	IV
Cb 103/A505	7	120	0.7	---	Pits Corrosion Products	---	72	Clear	0.453	---	IV
SCb 291/R508C	2	120	1.6	---	Corrosion Products	---	773	>P	1.574	---	IV

TABLE XX

SATISFACTORY MATERIALS FOR GENERAL USE WITH STANDARD HDA

Materials	Service At 90°F	Service At 120°F	Service At 220°F
Aluminum Alloys			
356A Cast	X		
356-T6	X		
5086		X	
5086 Welded		X	
5454-0		X	
5454-H32		X	
5454-H32 Welded		X	
6061-T6	X	X	
6061-T6 Welded		X	
300 Series Stainless Steel			
304L	X		(II)
316 Spring Wire	X		
347	X	(III)	
Other Metals			
17-4 PH H1025	X		
17-7 PH Fully Annealed Cond. A	X		
17-7 PH Spring Wire	X		
17-7 PH Torque Tube	X	(II)	
PT-CO Alloy		X	
Nonmetals			
Rulon 123	X	(II)	

TABLE XXI

MATERIALS SATISFACTORY FOR REPEATED SHORT TERM USE WITH STANDARD HDA

Materials	Service At		
	90°F	120°F	220°F
Aluminum Alloys			
356-T6			X
2021/2021 Welded	X		
2219/2219 Welded	X		
Nituff On 6061 Al		X	
300 Series Stainless Steels			
302/304L Weld		X	
304/304-308 Filler Weld	X		
304L/304L TIG Weld	X		
304L	(I)		X
304L Work Hardened	X		
316		X	
321	X		
321/321 Bellows Res. Weld	X		
321/321-347 Filled Weld	X		
347/347 TIG Weld	X	(III)	

Materials	Service At		
	90°F	120°F	220°F
Other Metals			
M-50 Alloy	X		
440C	X	(III)	
AM350 Screen	X		
17-7 PH RH 950		X	
17-7 PH RH 1050	X	X	
ARMCO 21-6-9	X	(III)	
20-Cb-3	X	X	
Haynes-25 Screen		X	
MP-35-N	X	(III)	
Nonmetals			
Kel-F 81	X	X	
Rulon A	X		
25% Glass-Filled Teflon	X		